Efficient biogas production with small WWTP including co-fermentation

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Experience from the planning and realization of more than 1,500 projects in the field of environmental protection in the last 35 years
Fields of specialization

Environmental Protection

Industrial wastewater
Municipal wastewater
Sewerage Systems
Water supply
Cost and fee calculation

Biogas-Project
Solid waste treatment
Plant operation
Project management
Turn-Key-Projects
# Fields of specialization

## Environmental Protection

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University of Hannover
Solid Waste Treatment Centre Hannover

incineration

mechanical sorting and composting facility

Fermentation

composting from the fermentation plant
WWTP Zarrentin
80.000 PE
Digestor
WWTP Zarrentin
80,000 PE
Digestor

Biogas from sewage sludge

0.5 – 1.0 m³ gas/m³ reactor/d
WWTP Zarrentin
80,000 PE
Digestor

More Biogas from sewage sludge + co-substrate

1,0 – 2,5 m³ gas/ m³ reactor/ d
Tönnies slaughterhouse Rheda-Wiedenbrück
(capacity 30,000 pigs per day)
River Ems
Slaughterhouse
Wastewater treatment plant Rheda-Wiedenbrück
Pre-Treatment of the slaughterhouse waste water
Flotation for slaughterhouse wastewater

\[ \eta_{\text{COD}} = 85 - 90\% \quad \eta_{\text{N}} = 65 - 70\% \]
Co-fermentation of sewage sludge and flotate

3,9 MW_{el}
Co-Fermentation of residues from Penicillin-Production and sewage sludge, NCPC China
Duplex-Technology
Co-fermentation of Sewage sludge and solid waste organic fraction

Waste Water Treatment

Solid Waste Treatment

Sorting

DUPLEX plant

sludge

organic fraction

reuse

recycle

landfill

compost/cultivation
H-Batch system for WWTP plants ≥ 10,000 PE

- Storage for stormwater (option)
- Sludge treatment: aerobic/anaerobic
- Biological treatment

Aquafilter Ingenieur GmbH
Dal Lake in Srinagar/ Northern India
... suffers under strong eutrophication
H-Batch-System WWTPs in Srinagar/ India
(5.400 m³/day & 16.100 m³/day)
DUPLEX
22,000 PE
Wastewater & waste
Solid Waste Sorting
Conditioning of the solid waste required

- Removal of plastics
- Removal of metals
- Removal of sand, glas, stones etc.
- Technology is available
- Downsizing for solid waste treatment plants
  < 50,000 PE required

- Generally:
  Treatment of the separate collected organics or
  Treatment of the complete waste
Solid Waste and Wastewater Treatment Center

DUPLEX-system

Capacity 20,000 PE
Conclusion

- Anaerobic technology has advantages (biogas production, less sludge to be disposed, less space demand)
- Co-fermentation of organic residues increases the efficiency of the reactor (up to 2.5 instead of 1 m³ biogas per m³ reactor)
- Examples for large scale application are available internationally
- Co-fermentation of sewage sludge and organic solid waste fraction can contribute to a sustainable infrastructure
aqua consult as your competent cooperation partner for all environmental projects
Technologies for the nitrogen removal in high concentrated partial streams

**Biological technologies**
- pre-denitrification or post-denitrification with external carbon source
- nitritation/ denitritation
- deammonification

**Stripping of nitrogen**
- with steam (product: ammoniumwater)
- with air and acids (product: ammoniumsulfate)

**Precipitation**
- production of MAP (Magnesium-Ammonium-Phosphate)
Technologies for the nitrogen removal in high concentrated partial streams

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Pilot Plant Nitritation – WWTP Dubai

Nitritation
T = 35 - 40 °C
Partial Augmented Nitritation Denitritation Alkalinityrecovery

Developed by aqua consult Ingenieur GmbH / ISAH, Universität Hannover
Deammonification with Pellets, WWTP Heidelberg
Biogasplant Pune for food waste
Cascade-denitrification with separated inflow to the single compartments

Zulauf

inflow

D = Denitrifikation
N = Nitrifikation
Rec = interner Recycle
Index = Nummer der Kassette

D = Denitrification
N = Nitrification
Rec = internal recycle
Index = number of the cascade

Ablauf

Nachklärung

Rec 1
Rec 2
Rec n

Final clarifier

Rücklaufschlamm
Recycle sludge

D1 N1 D2 N2 Dn Nn

effluent
WWTP Halberstadt, cascade technology, 60.000 PE
Caskadendenitrification, Kranj  95.000 EW
coarse-porous carrier fabric

suction beam 抽吸梁

crude sewage 原污水

Pile 累积

coarse-porous carrier fabric 粗的、有可渗透性织物载体

Filtrate 过滤
Cloth filtration
Oldenburg/ Germany
KA Kranj/ Slovenia (95.000 PE)
Cloth filtration
SS_{AS} = 3.0 \text{ g/l}
SS_{AS} = 4.3 \text{ g/l}
Cloth-filtration
Problem: Pharmaceutical residues in the waste water
Combination
Cloth filtration – Micropollutent Removal

- Cloth-filtration – Ozonation
- Ozonation – Cloth filtration
- Active Carbon – Cloth filtration
Adsorption-stage
Active carbon treatment stage for the removal of biologically inert COD
Thermal Hydrolysis

- Hydrolyse
- Thermal Hydrolysis

$T = 165 \, ^\circ C$

$P = 4 \, \text{bar}$

+ Biogas production

+ Dewaterability

- Sludge load
Sludgedrying

Anaerobic sludge Digestion

+ primary sludge storage
+ thermal hydrolysis
+ Co-Fermentation

= energetic autark operation
Industrial Wastewater treatment - closed water cycle in the fibre board production

Очистка промышленных сточных вод – закрытый водный цикл на производстве фибролита
Anaerob Pilot Plant
Pilot Plant Reactors

4 x 80 l Volume
Co-fermentation

3.9 MW_e
2 Combined heat power plants, 2 • 1,4 MW\textsubscript{el}
Industrial Park, Infraserv HOECHST in Frankfurt
Anaerobic treatment of the sludge

Aerobic 2-stage Wastewater treatment
Co-fermentation Project Shijiazhuang 5 Mw_{el}

(surplus sludge, organic production residue)
Digester Construction at NCPC Project
Inspection of the biogas reactor
V = 5,000 m³, Shijiazhuang/China
Digester Construction at NCPC Project
Anaerobic treatment of the organic fraction of the solid waste
- Separately
- as co-ferment
Environmental protection of the Dal Lake
Waste Water to Cleanwater – Water to Energy – Waste to Energy
The world biggest archimedian screw
Anaerobic treatment of the organic fraction of the solid waste
- separately
- as co-ferment
Mechanical-biological solid waste treatment
Backloading through nitrogen in the liquid residue

- high nitrogen loads after the fermentation

in the sludgewater from the dewatering facilities (centrifuges, Membrane-presses)

usually: 600 – 800 mg NH$_4$-N/l

with co-fermentation: up to 3.500 mg NH$_4$-N/l
N-stripping with steam from sludgewater, WWTP Cloppenburg
N-stripping with steam from sludgewater, WWTP Cloppenburg
- Application of the MAP-precipitation for sludgewater is still in the state-of-art phase
- Often used for manure treatment after membrane filtration
- Evtl. higher demands for the sludgewater quality
Growth rates of nitrosomonas and nitrobacter as a function of the temperature according HUNIK (1993)

Sludge age [d]
Technical Scale pilot plant for nitritation
Partial Augmented Nitritation Denitritation Alkalinityrecovery

Developed by aqua consult Ingenieur GmbH / ISAH, Universität Hannover
Components for the co-fermentation of flotate at the WWTP Rheda-Wiedenbrück

- **Sludgewater treatment (PANDA)**
- **CHP-plant**: $2,8 \text{ MW}_\text{el}$
- **Anaerobic digester**: $5,000 \text{ m}^3$ (exist.)
- **Anaerobic digester**: $6,500 \text{ m}^3$
Sludgewater treatment Rheda-Wiedenbrück (PANDA)
Schlammwasserbehandlung Rheda-Wiedenbrück

**NH₄-N [mg/l]**

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<tr>
<th>Betriebszeitraum [Woche]</th>
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<tr>
<td>0</td>
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<tr>
<td>Zulauf</td>
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<tr>
<td>Ablauf N1</td>
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Hydrozyklon

Pellets
Deammonification is an proved energy saving technology for N-removal.
Flotate as valuable energy source
Флотант как ценный источник энергии
Pre-treatment after flotation
Предварительная обработка после флотации
Refined compost as a valuable product in plastic bags ready for selling